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tions of the relations and utterly heedless of the entities which may stand as their terms.

The 'Theory of Dimensions' is especially interesting from the fact that it does not involve ordinal properties in the accomplishment of its end. We begin by defining a ϕ -class, i. e., a class such that if u is a ϕ -class the proposition $\phi!u$ is true, and then by definitions of ϕ -regions and subregions we come upon certain properties of some ϕ -classes such that we can say that any class having those properties is a ϕ -point. From this point on it is a straight road to develop a complete geometry and finally arrive at a concept of a material world, but it is in these subsidiary theories and not in the concepts themselves that we believe the highest value of the paper lies.

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Aktionsströme vom Gehörorgan der Fische bei Schallreizung. H. PIPER.

Zentralblatt für Physiologie, Bd. XX., Nr. 9.

Die akustischen Funktionen des inneren Ohres und seiner Teile. H.

PIPER. *Medizinische Klinik*, 1906, Nr. 41.

Although the ears of fishes possess no cochlea, Zenneck and G. H. Parker have shown that these vertebrates respond, nevertheless, to sound stimuli. This response must, then, be mediated by some or all of the sense-organs in the ampullæ, utricle and saccule of the ear, or else by some organ outside of the ear. Investigators who hold the Mach-Breuer theory that, in the higher vertebrates at least, the cochlea alone is the organ of hearing have suggested that the hearing of fishes is probably mediated by sense-organs located in the skin. But Parker has shown, by severing the sensory nerves leading from the lateral line and other parts of the skin, that in some species at least the response to sound vibrations is mediated by the cochlealess ear. Piper has now studied this response, in the pike (*Esox lucius*) and eel, by means of action-currents similar to those demonstrated for the retina by Holmgren. Earlier work with these currents has shown that in general any active organ or tissue is electronegative toward other near-lying and non-active organs or tissues; and if when both are at rest the former shows a positive difference of potential toward the latter, this positivity (rest-current) is decreased when the former is excited. "Such fluctuations of potential, or action-currents, are a sure indication of the presence of functional changes in the organism."

Piper applied one electrode to the large otolith of the saccule (or to that of the utricle) and the other to the exposed section of the acoustic nerve, or to a near-lying part of the inner surface of the skull. The rest-current shows the otolith positive while the nerve section is fresh, but this current is gradually reversed as the exposed end begins to die (*absterben*). The sounds were produced under water by two whistles, of 100 and 260 vs. The action-currents always showed an increased negativity of the otoliths, and they subsided as soon as the sound ceased. "The deflection of the needle is greater when the sound stimulus lasts

longer, and when it is more intense. . . . Very faint tones, or a gentle tapping of the sides of the glass dish, suffice to produce the typical fluctuations of current in the ear of the pike. Soundless mechanical jarrings of the preparation, . . . or stirring of the water, *et cet.*, have no electromotor effect. . . . If neither of the two electrodes lies on the large otolith nor in its immediate vicinity, any parts from which the current may be drawn are indifferent to sound stimulation, and the current does not fluctuate."

"The above, readily-repeated experiments may be taken as positive evidence that fishes react to sound by means of their labyrinths. They have a comparative physiological importance in that they strongly support the view that has been chiefly defended by Hensen, and otherwise almost universally abandoned, that even in the higher animals the inner ear in all its parts, including the sacculus, utriculus and ampullæ, subserves essentially the functions of hearing."

The second paper above cited contains, after a condensed account of the anatomy and physiology of the inner ear, a discussion of the probable functions of the ampullæ and the two sacs. The author does not deny the Mach-Breuer theory that they serve as organs of a static sense (along with joint, dermal and other sense-organs). But he believes that they also, and probably primarily, mediate sensations of noise. Among other things he points out that resonators can not respond to noises (by reason of the interference between waves of many various periods) and that, therefore, if, as is believed, the radial fibers of the cochlea are resonators, these can not be the sense-organs of noise; that the researches of Hensen and Deetjen, not to say the plain facts of anatomy, prove that the nerve endings in the canals and sacs are affected when noises stimulate the ear; and that the researches of Parker and those (above reported) of Piper prove that in vertebrates at least as high in the scale as fishes, the labyrinth *does* contain the end-organs of sound. "The conclusion is, therefore, that the labyrinth in all its parts is to be accounted an organ of hearing. . . . in any case it seems to me that after the facts here adduced, the assumptions of the Mach-Breuer theory in its present formulation can scarcely be allowed."

The facts offered in these two papers deserve careful consideration, and, in the reviewer's opinion, Dr. Piper is right in saying that the extreme formulation of the Mach-Breuer theory (which substitutes the name 'statolith' for otolith) needs emendation. Those who have read the papers of Breuer will scarcely be able to give up the belief that both canals and sacs are concerned in our equilibration; but, on the other hand, it is almost inconceivable, in view of the anatomical position of the *cristæ acusticæ* in the *sacs* at least, that noises do not 'adequately' stimulate these organs. It is less clear, and is not proved by Piper's work, that the *cristæ* of the *canals* are so stimulated. While it seems well shown that the sacs participate in the perception of noise, it may be less certain than the author indicates that the interference between the components of noise stimuli is so complete as to exclude all participation of the cochlea. It seems highly probable that the sacs, and per-

haps the canals, subserve two very different functions; and yet if this is the case, a problem arises as to why movements of the head are never sensed as noises, nor noises ever felt as movements.

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Objektive Bestimmung der Schwingungszahlen Königscher Flammen ohne Photographie. KARL MARBE. *Physikalische Zeitschrift*, 1906, Bd. 7. S. 543-546.

The author let a König flame play under a moving paper roll, and found that if the paper was near enough somewhat to deflect the flame successive rings of smoke were produced which, when the speed of the paper was rightly adjusted, could be easily counted, and which accurately reproduced the vibration rate affecting the flame. Acetylene gas was used, and the sound was taken from a tuning-fork mounted in a special way on a resonating box. Again, the König membrane was replaced by a telephone membrane and connected with a microphone, and very interesting smoke pictures were obtained of spoken words. This method of recording oscillations of the König flame is simpler and cheaper than the photographic. The chief manipulative difficulty would seem to be that after passing the flame the paper is immediately rolled on a drum before the smoke curve is fixed. Yet the author reproduces excellent curves of tuning-fork vibrations, circuit alternations and spoken words. The photographic method if carefully handled gives more detail, yet the smoke curves of the voice look as if, on careful analysis, they might yield more intricate details than merely the fundamental pitch of voice sounds. They ought, moreover, admirably to record accent and syllable length in spoken verse. The method is interesting, and the curves that are reproduced are well worth looking at.

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JOURNALS AND NEW BOOKS

ZEITSCHRIFT FÜR PSYCHOLOGIE UND PHYSIOLOGIE DER SINNESORGANE. May, 1906, Band 41, Heft 5 u. 6. Abteilung für Psychologie. *Theorie der geometrisch-optischen Gestalttäuschungen* (pp. 321-348): LUDWIG BURMEISTER. - The first of a series of papers based on a very careful study of geometrical optical illusions. The observations in this paper are confined to illusions of perspective with right-angled plane figures or cards. Derivation of the fundamental theoretical relations between the *Objektgebilde* and the *Truggebilde*. *Beobachtungen über das Leben der Protozoen* (pp. 349-381): ANTON ÖLZELT-NEWIN. - General observations on the reactions of various protozoa by an observer apparently ready to attribute any degree of consciousness to these forms. Chief argument is that of continuity, the consequences of which would lead to ascribing a psychic minimum as a disposition to the cell. *Ueber*